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VEGETATIONAL CLIMAXES OF THE STATE OF NEW YORK

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INTRODUCTION

The natural vegetation of any sizable area usually presents enough contrasting features to arouse mental, if not verbal, questions as to why or how variations would appear so frequently. The State of New York has many features that permit a variation of the vegetational climax. The purpose of the following treatment of the subject VEGETATIONAL CLIMAXES OF THE STATE OF NEW YORK is to make an acquaintance with the factors that influence, or, more truly, help to cause the varied vegetation within the State of New York. In pursuit of this goal the writer considers the totality of the floral members of any area as one unit, namely, "the vegetation of that area". In the light of this, climax forms whether in associations, societies, or pure stands are given much more significance than a digest or analysis of the individuality of floral members in an area. The term "factors" is inclusive, geological, geographical, climatci, and biological phases being thus grouped together.

VEGETATIONAL CLIMAXES OF THE STATE OF NEW YORK

I. Geological Background

> "America is called the 'New World', but, as we now know, that portion of North America which lies immediately north of the St. Lawrence and the Great Lakes, with its extension southward, the Adirondack region, is the oldest part of the earth's surface. This land area, sometimes wider, sometimes narrower, and gradually increasing, has continued to exist throughout all geological time; hence it is not surprising that we have here the most complete and connected history of plant life."[1]

Part of this land sank in Lower Silurian time, and the sea covered a large area; for example, the Potsdam sandstone is found to contain abundant marine fossil forms being

> "in a thousand places covered thickly with a network of interlacing stems of seaweeds, or rather their casts, because the vegetable tissue has all disappeared."[1]

Not much is known previous to the Silurian Age except for quantities of carboniferous matter now graphite of plant origin, either of marine plants or of land plants.

While the land mass of the Upper Silurian Age was less extensive, there are in its deposits "indisputable evidence of the existence of land plants."[1] This evidence is in the form of remains of ferns, lycopods, equisetae, and conifers, small in size and rather few in number, indicating that land vegetation must have been rather sparse.

> "The subsidence giving rise to the series of sediments of the Devonian System was less extensive than those taking place before the area of permanent

land was greater, but the proof that this land was covered by a luxuriant, beautiful, and varied terrestrial flora is conclusive."[1]

Dawson describes over one hundred species of fossil plants from the Devonian rocks of Canada and New York. The most interesting Devonian plants are found in the limestone of Ohio and the Hamilton rocks of Gilboa, N. Y. Apparently there was a time when the land submergence produced a series of islands from the Great Lakes to Tennessee. On the "shores" of these "islands" there are remains of similar plant life. Along one of these shores at Gilboa are found tree forms of several sorts, some of the trunks being two feet in diameter; Noggerathin, a supposed cycad; Lepidodendron, a lycopod; and (according to Dawson) Psilophyton, connecting the ferns and lycopods which were widely found in the Devonian Age.

The Carboniferous Age continued an expansion of the Devonian Age. Newberry[1] thinks about one-half of the Carboniferous forms of plants should be considered identical with similar forms of this age in Europe. It is interesting to note that New York contains very little coal while near-by Pennsylvania has very extensive coal beds. One might then infer that the abundant vegetation usually thought to belong to the Carboniferous Age was not present in New York. This would not necessarily be true, for general mass movement of water could easily remove vegetation in one region and pile it up or deposit it in another region. The Triassic and Jurassic floras, Newberry considers essentially alike in

botanical character. There is a complete change from the paleozoic to the Mesozoic era. The lycopods have become insignificant, the sigillarids are extinct, and the calamites have given away to the true equisetae. The conifers and cycads have multiplied until they have become the most conspicuous forms of vegetation. The conifers were Araucarians; some with close, rhomboidal, appressed discs for leaves; others with divergent fleshy scales like the present Brazilian Araucaria; and still others with filiform leaves like the modern spruces. The cycads were almost infinitely varied, some aborescent with lofty trunks crowned with graceful canopies, other spheroidal masses marked with rhombic leaf scars. Remarkable changes occurred in the ferns also.

The changes of the Cretaceous Age were the most complete of any period, developments not understood occurring not by transition but by sudden eruption. The angiosperms seem to have spread over the face of the earth by the beginning of the Cretaceous period. Bray[2] cites them as being widely distributed by the end of the Cretaceous period. Newberry[1] thinks the Cretaceous sea invaded a forest of oaks, willows, sassafras, magnolia, tulip tree, sweet gum, in fact many forms of our present flora. At this point Bray and Newberry are in dispute. Bray agrees with Newberry in general as to existing forms, but he goes on to submit the idea that much of our present flora began in the Arctic. As a gradual cooling took place the floral society migrated southward, only

the hardier remaining until the advancing cold overtook them. As evidence he submits the picture represented by the order in which fossil forms of plant life are found in the Arctic and southward. Nearest the surface of present day Arctic flora are found sub-Arctic forms. Beneath these are more temperate forms and yet beneath the temperate forms are fossils of sub-tropical and tropical plants. Newberry suggests that since the forms of this period are so similar to present day forms a mild temperate climate must have prevailed over all North America, permitting a migration northward of the more southern flora. Some geologists advance the theory that at this period a land bridge from northern Canada and Greenland to Europe by way of Iceland and the New Hebrides made possible a two-way migration or exchange of floral forms, thus accounting for the great similarity of northern European forms and North American forms. At present an elevation of only two thousand feet across this region would produce such a land bridge, a small altitudinal difference in great crustal fluctuation. The same type of bridge to Siberia across the Bering Sea is thought to have been probable.

According to Newberry[1], the floral climax of all time was reached in the Tertiary Period. He calls our present flora a mere wreck of what it was before the Ice Period, if we judge from the aborescent plants. He claims that more forms have already been found as fossil than exist now on the earth's

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surface.[1] He reports fossil sycamore leaves two feet in diameter of a half dozen species now extinct, camphor trees, palms, and figs, which were general features of the Tertiary but are now found only in the tropics.

The close of the Tertiary era is recognized by most geologists as being a period of great terrain movement or change; mountains already formed were modified, more mountains reared up by great crustal fluctuation and more land appeared above the sea level. Changing conditions had already produced greater adaptability of plant life to existing conditions so that the Angiosperms, which had now become dominant almost everywhere, could better stand further changing of conditions.

The Angiosperms seem to have become dominant almost everywhere by the eve of the most recent of geological eras, the Glacial Period. This period is commonly understood to have been a time when temperature and moisture conditions permitted the formation of great ice sheets which moved down over New England, New York, and the upper parts of the Appalachian range. Very obviously, this would have a profound effect upon vegetation. Indeed, if the species were not destroyed, they would have to migrate southward. This seems to be just what did occur; the species migrated southward and southwestward of the area dominated by the ice.

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As far as the major aspects of the present flora are concerned it matters very little whether there was one period

of ice or whether there were several periods with intermittent short periods of floral re-occupation. Of course, consideration should be given to the probability that the various ice "invasions" did not cover the same area each time and hence in isolated areas vegetation representative of various periods of floral re-occupation might persist down to the present. The final recession of the ice sheet or its last "invasion" marked the beginning of the present day floral conditions in their major aspects.

No stretch of imagination is required to see the significance of the vast and effacing effects that an occupation of the land by heavy ice sheets would have upon the terrain. Previous covers of humus and rich soil often would be stripped off and be pushed into depressions, leaving bare rock in the higher places. A general disfiguring of the surface would result. Most of the lower hills were rounded off, for these would be more likely to be covered by ice, whereas the highest points may have escaped the ice covering. In fact, the possibility of peaks being missed by the ice has been suggested as a theory explaining the occurrence of Arctic vegetation on some of the higher peaks. Many huge deposits of rocks and boulders, with adjacent beds of varying gravel and sand, find explanation in no other way than through the disintegration of great ice sheets by the return of higher temperatures.

Thus we are confronted with the task of floral re-occu-

pation of a difficult terrain even though the forms could have been saved in the "ark" of a southern retreat. Newberry with mournful eloquence comments upon this return of the flora after mentioning the destruction of the Tertiary fauna.

> "Hence, of the grand Tertiary fauna scarcely a remnant survived, while of the plants, when better days returned, and the snow fields and ice sheets retreated to Greenland, a sufficient number came back from their banishment to cover the central portion of the continent with a flora which retained all the essential botanical features of the Tertiary, but the vicissitudes through which it had passed had told sadly upon it. Many of its grandest and most beautiful elements had disappeared forever, while a few of its magnolias, tulip trees, sequoias and liquidambars survive as solitary representatives of the group to which they once belonged and form groves instead of boundless forests. Overtopping in their splendor, or outshining in their beauty present associates, they attest the general magnificence of those ancient forests that were composed of their progenitors and extinct relatives, their equals or superiors."[1]

In general the period of floral restoration can be noted as being the period from the close of the Glacial Period down to the advent of the white man in America and, in a part, down to the present. In this restoration we find a determined orderliness which can be and is modified by environmental exigencies, but even these interruptions or variations proceed with an orderliness more consistent than bookkeeping and more certain of resulting in a balanced condition.

B. General Topography of New York State

Geologically, the geography or topography of land is the result of all forces that have worked upon it and still continue to operate. We find the State of New York little affected topographically by man, but modified greatly in its surface appearance.

The whole state can be said to have two extensive elevated portions, the Catskills attaining a maximum of 4,205 feet and sloping down to the tide-affected Hudson and the Bay of New York, and the Adirondacks reaching up to over a mile above sea level on Mt. Marcy (with an altitude of 5,350 feet), the foothills of which slope down gradually in the north to the St. Lawrence only a few feet above sea level and to the Mohawk and Hudson in the south.

The topography of the state takes on several clearly discernable plateaus or basins onaccount of this altitudinal variation and the position of these two groups of mountains. On the east we find, running north and south, a basin slightly above sea-level, formed by the drainage of the Hudson and that of Lake Champlain. These two bodies of water come so closely together than a navigation canal connects the upper reaches of the Hudson with the Lake Champlain-Lake George system. About midway in this basin and striking off to the west, we have a slightly higher basin formed by the Mohawk River, reaching to a region just northeast of the Oneida Lake basin. The Mohawk basin is met on the west by the

flanking northern reaches of the Lake Ontario basin which includes the Oneida basin on its eastward inland extension. The Ontario basin extends westward to Niagara and inland reaches south to the basins of the Finger Lakes. The northern reaches of the Ontario basin show no demarcation with the St. Lawrence basin which reaches up inland to the valleys of the northern slopes of the Adirondacks. To the southwest, the Ontario basin rises gradually to merge with the slightly higher Erie basin. These basins are often called Erie-Niagara-St. Lawrence and Ontario-St. Lawrence basins, but for ease of allocation we speak of them separately. We speak of the St. Lawrence basin as that part of the valley formed by the actual river St. Lawrence as it contacts New York State. The Champlain basin is often called the Champlain-Richelieu-St. Lawrence basin.

Along the southern part of the state, neighboring Pennsylvania, we find a generally raised plateau interrupted from the western to the eastern part of the state by the basins of the tributaries of the Alleghany, Susquehanna, and Delaware Rivers. Thus we find the physical aspects of the state determined by drainage away from the highest points contained within itself. The largest similar or single region of the state, the Adirondacks, becomes contributor to: the Hudson basin by drainage of the Hudson and Mohawk rivers southward, the St. Lawrence by drainage of the Black, Oswegotchie, Grasse, and St. Regis rivers northward, and to

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the Champlain basin by the Saranac and Ausable rivers eastward. As will be brought out, these basins operate to permit inclusions of flora which on a general plateau in the area would not be found. Close analogy of frost-free days to altitude will also be seen.

II. Xerophytic Succession in New York State

The whole state of New York has already been described geologically as being a glacially-prepared terrain. Features would rather frequently occur offering plant habitats deficient in water supply. There are several types of such habitats, outlined as follows:

1. Surfaces of bare rocks as glacial stream beds, rounded dome-like summits of hills and mountains in the Adirondacks, the Catskills, Hudson Highlands, vertical sides or ledges of mountains, and deeply cut stream beds.

2. Accumulations of rock fragments and mounds or areas of round boulders deposited by melting ice.

3. Sand deposits, dunes, deltas, lake shores, and glacially-distributed sands of the Adirondack rock which is largely gneissic.

4. Exposed hills and slopes consisting largely of gravel and sand or with a very thin cover of till.

In the first two of these conditions, fissures and spaces or pockets permit the lodging of sediment, both mineral and organic, and the holding of water, thus encouraging vegetation. Steady seepage may even promote an almost hydrophytic condition, as is the case in many of the mountanside swamps in the Adirondacks.

In the third case the development of the heath-shrub climax is indicative of this previously prevailing condition.

In the last circumstance, mesophytic conditions finally permit the typical well-developed forest vegetation, if not the forest climax.

In Figure 1 taken by the writer on the heights of Whitehall, New York, we see the climax of mesophytic conditions which developed from a Xerophytic habitat of the first type. Various red and black oaks of no large size are mixed with service-berry, birches, and maples, both hard and soft; the white pine does not reach the handsome size it does on deep soil. The ground cover is shrubby, being composed of various blueberries, sweet fern, bracken fern, columbine, various saxifrages, strawberry, cinquefoil, and occasional patches of winter-green.

Figure 1

In the vicinity of Saranac there are many rocky promontories which must have been bare rock. At present various stages or successions under typical conditions are observable. In general, many of these areas are covered with sugar maple, yellow birch, beech, hemlock, paper birch, red spruce and a varied forest floor, or general conditions of floral zone 3 overlapped by some indicators of the Canadaian Transition floral zone. (Floral zones will be discussed under

Mesophytic Succession or Extension in New York State.) The process of occupation of bare rocks by vegetation is common ecological information, the succession of crustose lichens, foliose lichens, mosses, small flowering plants, woody plants, small shrubs, larger shrubs, and the vanguard of forest species eventually bringing on the limited climax of hardwoods (limited by soil depth).

Sand offers the most interesting development of the xerophytic type of terrain. The appearance of sand flats in New York State points geologically to a time when the Mohawk, Hudson, Saranac, and Balck rivers emptied at a much higher level than they do now. These rivers now continue far past what was once their deltas. The writer has observed the great sand bed country of Great Bend on the Black River. The river now extends on down to Lake Ontario, cutting through vast layers of limestone and, lower down, nearer the level of Lake Ontario, slate. On the sand beds referred to, white pine stands of good size indicate the original climax. On the plains off the sand beds we have the clay beds of old Lake Iroquois which support a thinned-out mixture of zone 2 and dominants of zone 3. (See Figure 12).

In the case of the Plattsburg Sand Plains we have a condition very similar to the Black River Sand Beds. However the sand flats persist all the way to Lake Champlain, the Plattsburg beaches being one of the greatest inland or

Figure 2

freshwater beaches in America. Limestone beach occurs between the reaches of sand bed formations of the deltas of the Saranac and Ausable rivers. The Plattsburg Sand Beds have a larger area of less luxuriant growth than most of the other sand areas of the state. The most conspicuous forms are semi-dense stands of gray pine or bank-siana (see Figure 2) and pitch pine (see Figure 3). Photos were taken some thirty miles apart on the Plattsburg Sand Plains. Associates of these are white pine (mixed with hardwoods in small areas of more deeply accumulated loam), scrubby red oaks, fire cherry, service berry, and common poplar. The ground cover is largely composed of various kinds of blueberry, shrubby service berry, sweet fern, lamb-kill, wintergreen, and various other small heaths and bracken fern. This region is, in general, a dryer region than the other large sand areas of the State. Figure

Figure 3

Figure 4

4 illustrates a condition found over large areas of the Plattsburg Sand Plain.

Another type of sand bed succession or climax is found along the shores of Lake Iroquois, the old parent of Lake Ontario. The rim or shore of this is now occupied by the "Ridge" Highway, given over to fruit-farming, and having only scattered small areas indicating the conditions of zone 2. Near Rochester, along the shores of Lake Ontario, we find conditions of hydrophytic succession on the otherwise xerophytic sands. Examples of this are the cut-offs of Irondequoit Bay and the marsh meadow of Charlotte. The most typical xerophytic development on sands of this area is found on the shores of Lake Oneida. Here Bray[2] describes Polytrichum mats with sparse vegetation of leather leaf, after which black chokecherry and witherod occur sparingly. Pioneer forest is followed by thickets of gray birch and smaller amounts of aspen.

The "Plains" of the upper Oswegotchie present yet another sand development. These plains are unique in their definite lines of demarcation from regular forest. But the forest is (with a narrow margin) creeping out by regular

succession onto the open plains led, strangely enough, by tamarack, an indicator of bog conditions. The open plains are essentially a heath formation with progressional stages from Polytrichum to small shrubs such as various species of blueberries (the writer has picked blueberries in abundance), followed by creeping blackberry and larger heath-shrubs up to the invading tamarack and black spruce. This mingling of typical sand barrens and typical bog is unique, inviting study. (Bray[2])

The most interesting of sand areas is the northern extension of the New Jersey pine barren flora on Staten Island and Long Island. The famous pine barrens of New Jersey extend with few interruptions from the Lower Bay of New York to Cape May and the mouth of the Delaware River. Its northern portion is a narrow belt near the Atlantic coast, but it expands as it extends southward so as to include nearly all of southern New Jersey. The flora of this region includes many of the most beautiful plants of North America. (Britton[3]) The soil of this area is generally extremely sandy, but it is occasionally more firm in places where strata of clay approach and form the surface.

The pine barrens of Staten Island and Long Island are a northern extension of the sandy stretches of Cretaceous Age. Much of this northern extension is covered by Glacial Drift deposits. Of the characteristic plants of the pine barrens, there are thirty-four appearing on Staten Island

and Long Island are found in New England. (Britton[3]) However, Britton has not taken into consideration the fact that a number of these characteristic sand barren plants are found on the mainland up the Connecticut coastal plain, Cape Cod and even as far north as Nova Scotia in Canada and on the western coast of the island of Newfoundland.

Bray considers the flora of the sand areas essentially the same except for the modification of surrounding dominating floral zone types. The Oneida Lake sand flat, where Polytrichum and leather leaf are dominants, and the "plains" of the upper Oswegotchie, where lichens and Polytrichum constitute the main ground cover, suggest an interesting comparison with the pine barren and heath formations of Northern Germany. (Bray[4])

The soil conditions on sand areas are in general very similar. The following is a sketch illustrating the layers the writer has checked in several sand bed areas about the

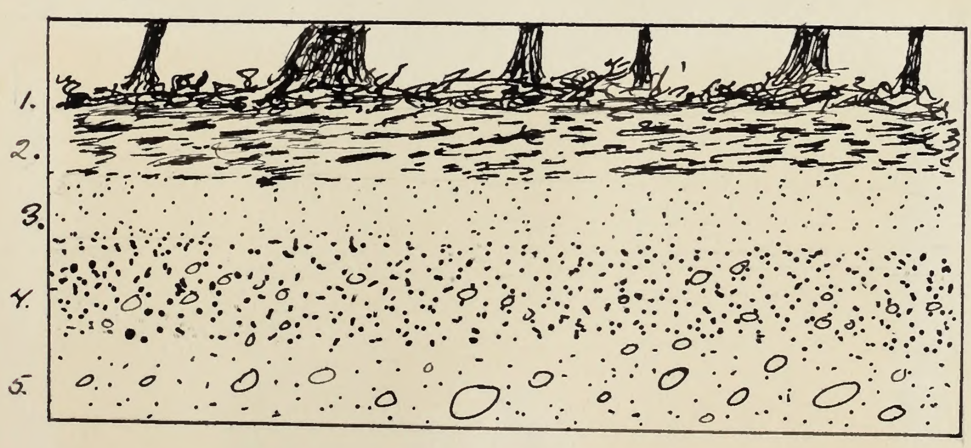

Figure 5

Adirondacks, varying a little in some cases, but in general holding quite true. Layer number one varies in depth but consists of vegetable matter just in the beginning stages of decomposition. The second layer varies in thickness necessarily as the first layer varies in amount. This is the layer of partly to thoroughly decomposed organic matter. The third layer of fine gray sand is three to six inches thick. Beneath this is a varying layer of blackish sand stained by organic and decomposed mineral matter seeping down. Below this is the "bed" of varying yellow sand and mixed gravel. Tree roots come well down into the "bed", probably for water, but they also have peripheral roots in the third and fourth layers.

III. Hydrophytic Succession in New York State

The coast line of New York State is limited to that part of Long Island not yet occupied by industrial and recretional beaches, so far as natural ecological development is concerned. The most of what is known of the flora of the cosmopolitan New York area is from recordings of rather long standing, preceding the rapid development of the city area. The shores of Lake Erie and Lake Ontario have the proportions of sea shore without the same proportions of bodies of water that are as brackish as regular sea shore. The many lakes of the Finger Lake region and the mountain region of the Adirondacks have areas of "Cut-offs" from the main body of water where vegetation is undergoing the regular hydrophytic succession. There are also many "kettle-hole" ponds scattered over the state. These "kettle-holes" in the heavily wooded areas usually are strongly acid bogs, no doubt owing to the large amount of decaying and undecayed vegetable matter plus chemically strong seepage into the ponds. Where these small ponds occur in more cultivated areas and less heavily wooded areas, we find the more typical shore succession of plant life.

Figure 6 is a diagram showing the usual process of mesophytic development from hydrophytic conditions. This diagram is based upon general discussion and description of bog and forest formation over water areas. The figure is of

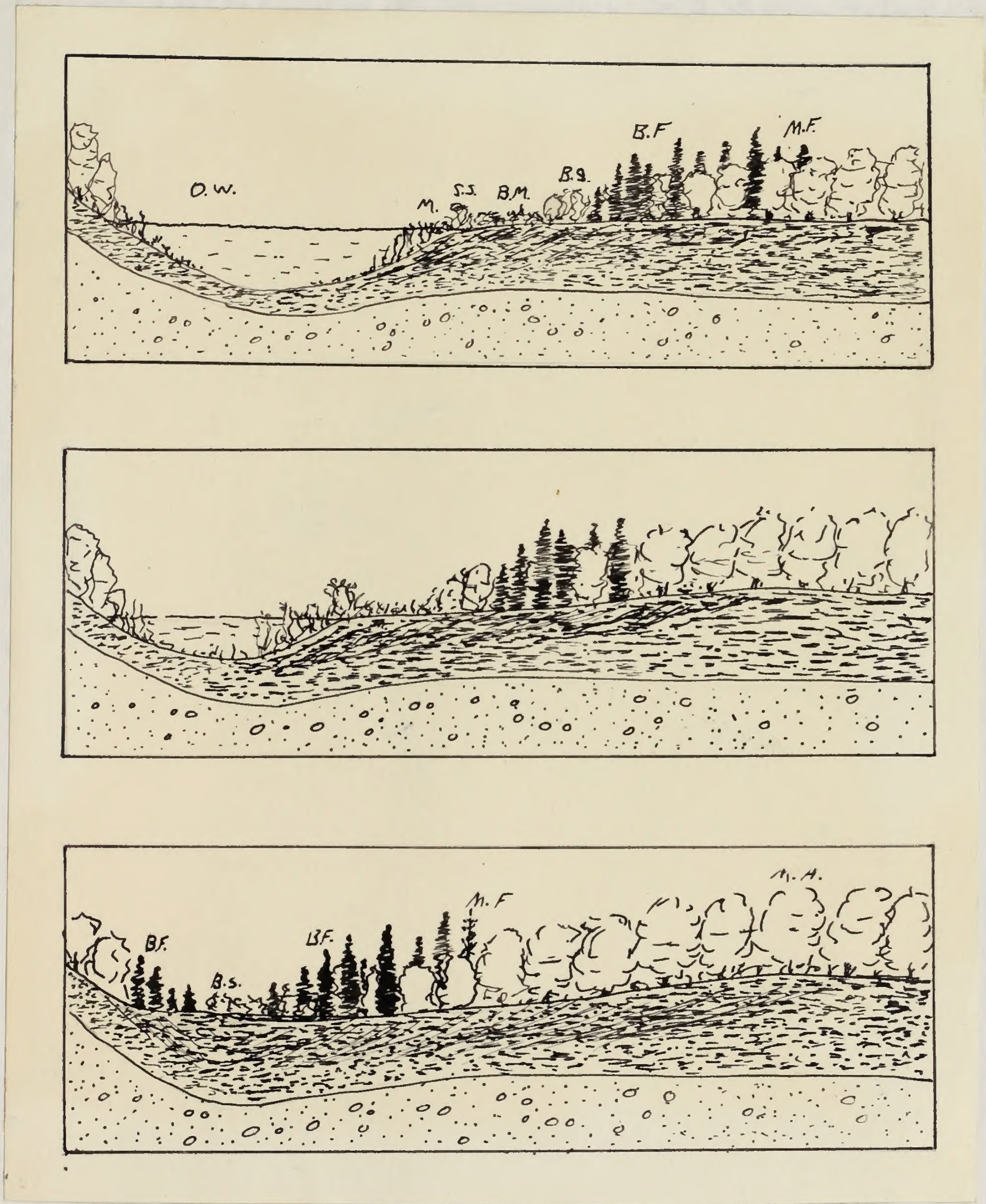

Figure 6

Diagrammatic representation of succession from open water to Mesophytic forest. O.W.--open water, M.--marginal succession, S.S.--shore succession, B.M.--bog meadow, B.S.--bog shrub, B.F.--bog forest, M.F.--mesophytic forest, M.H.--mixed hardwoods. Suggested by A. Dachnowski[4] in "Geological Survey of Ohio" Bull. 16, Columbus, Ohio, 1912.

typical conditions where the amount of water or "water table" could become incorporated in the newly forming duff without leaving an excess of water which would produce a stagnant bog which would seldom if ever become fully adjusted to mesophytic conditions.

In some cases lakes have certain periods of "blooming", a period when colonies of minute algae form plentifully and rapidly. Good examples of these are Conesus Lake near Rochester, and Oneida Lake. The writer has noted how this occurrence in these lakes has produced thick layers of scum on the surfaces of quiet bays, scum which by heavy wave action is often cast up on shore, becoming incorporated with the organic matter of the shore soil. These lakes (and wherever this condition would prevail) are found to have a fine, yellow-peat-like structure to a considerable depth below the turf. Also the bottom becomes covered with an ooze-like sediment from the decaying and settling of this matter. This is not overlooking the fact that animal plankton contributes substantially to lake-bottom sediment, for the presence of peat-like material is evidence of vegetable origin. Bray[2] lists duckweeds of the Salviniaceae of the Pteridophytes and liverworts of Ricciaceae of the Hepaticae among the floating plants in New York lakes. Potomogetons form the bulk of submerged plants in many lakes.

Graham and Henry[5] report an interesting behavior of shore succession from observance of fluctuation of Deep

Pond near Wading River, Long Island. From 1926 to 1933 this lake had various water levels. It had sunk steadily a few years, in 1927 it rose rapidly, then thereafter sank steadily. The lake's level is regulated by the mean water-table of the land. A two-year lag in height over seasons of heavy rainfall is conspicuous. The lowest level recorded is two years behind the lightest rainfall. The border strip of new shore, left from each year's dropping of the water level, exposed plants of the submerged type. Of these, only those more adaptable to exposure remained as the more land-loving plants that border water crept down from the ring of vegetation to the landward and proceeded to coccupy the new strip. This progression year after year from the landward side resulted in forming very observable "rings" of societies down to the water's edge. The sudden high water drowned out the land plants not adaptable to submergence, most conspicuous of which is Pinus rigida. Farther back on shore at another period dead Pinus rigida indicated an even higher flooding. This is a good illustration of the advance and retreat of vegetation along lake shores. But the filling in of cut-offs is more definite and permanent than lake shore fluctuation. Figure 7 shows an example of what often happens to a small brook. A flooded area is invaded by cat-tail followed by iris, after which alders form a firmer mat and offer raised hummocks where even white pine can take a stand. Figure 7 shows dominance of white pine on higher soil. This photograph was

Figure 7

taken in a depression of the general Plattsburg Sand Plains. Figure 8 shows the persistence of vegetation in returning to its own habitat and producing mesophytic conditions. This pond has been under the writer's observation for over twelve years. First, some beavers made a dam on a small brook. The water flooded out a stand of balsam, red, white, and black spruce, and even tamarack. The C. C. C. cleared away the old beaver dam, cleared off the dead trees and made a pond. The "bar" in the middle of the pond was just below water level, with cat-tail growth coming above water level. Since 1932 this bar has emerged and become covered by cranberry as a result of the mat-forming activity of the cat-tail.

The great muck-farming area of Montezuma swamp presents every indication of having been built up by the mat-forming activity of cat-tail and its associates.

Figure 8

The writer has noticed with interest the broad waving cat-tail acres in the region of the Montezuma swamp here and in the Irondequoit Bay near Rochester. Back of the cat-tail comes an invasion of shrub willow and equisetae followed by ferns, building up a muck turf.

Another type of muck-farming area in Cicero's swamp south of Lake Oneida presents a different type of succession. Bray[6] reports findings of built-up soil of clear peat and occasional marl beds down to a depth of at least thirty feet. Obviously this great depth was formed as the result of obstructed drainage. The succession here was probably from open water vegetation stages to Sphagnum containing grass and sedge marsh, to smaller, heath shrub and later to high shrub (high-bush blueberry, mountain holly, choke cherry, etc.). The swamp forest stage here is now conspicuously dominated by white cedar, tamarack, and black spruce although red maple is common also. The natural succession of this area is now being upset by agriculture. In the western part of the swamp the natural succession is being maintained where a free drainage channel has been kept open by natural means. But with the probable exception of the Adirondack mountain area, swamp forests in New York in general don't have such simple sequence. Settlement of the country removed much of the swamp forest, the drier areas being tilled, the wetter areas reverting to marsh meadow. Along streams willow and alder have developed a reversion to the shrub stage

which is often found to have been invaded by soft maples followed by ash and some elm.

Figure 9

Figure 9 shows a type of development from hydrophytic conditions which will arrive at Mesophytic climax only after great delay. Photo was taken near Saranac Lake in a pocket-like area between promontories of the type already described. Occupying the center of the bog are various heath plants bordered by tamarack, balsam, and black spruce. Interesting to note was the fact that in spite of the difference in size the tamarack and other conifers near the middle of the bog are very little younger than those farther back in conditions more favorable for growth. This indicates a probable acid condition of the bog water that retards growth. The stand of conifers on the left gives way to a climax of white pine on a slightly elevated ridge or esker of sand. This is probably a glacial "kettle hole".

Figure 10

Figure 10 illustrates a common development or relationship of bog and mesophytic forest climax. The brook has been forced to deepen by the action of turf formation by plant development. The bog shrub stage gives way to typical bog forest which in turn is invaded by mixed hardwoods.

IV. Mesophytic Extension in New York State

A. Factors of Climax Growth

Ecologically the whole state must be called Mesophytic, a condition of regulated water maintenance sufficient for the needs of luxuriant growth and having capacity features for the disposal of excess water. It is, in other words, a condition of adequate supply of water and drainage consistent with adequate growth. In general, mesophytic conditions evolve from or are the climax of either xerophytic or hydrophytic succession. Thus the interpretation of mesophytic conditions by following the succession from xerophytic or hydrophytic conditions is aided by an understanding of what probably produces mesophytic conditions. Of course, there is possible a direct mesophytic climax upon terrain ideally provided for such development. Vegetation itself tends to produce mesophytic conditions. This is clearly seen in either development already considered. If the humus contant of any tilled area leaches out or is consumed, the area may become dry if its former condition tended toward a xerophytic order. Or, if its former condition were hydrophytic, it will become wet and acid. Thus we can see that vegetation itself has more to do with producing mesophytic conditions than any other one factor. It is in light of this understanding that the writer purposely delayed the consideration of factors most directly affecting plant life and the consideration of

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floral distribution or zonal indication until the means of understanding them were portrayed.

Light becomes a limiting factor in the mesophytic forest. The difference of ground cover in a deciduous forest with a great variety of leaf shapes admitting larger amounts of light to the surface is vividly in contrast to the thick, coniferous forest with so little light on the soil that few forms develop there. It is consistent with this natural fact that seedlings of young conifers develop at their optimum in more shade than do those of deciduous plants. Many plants have developed this capacity of shade tolerance to such an extent that they require partial shade for their optimum growth and clearing away of the climax growth of overhead forms does away with many of the ground cover forms. Light is associated with heat and the larger amount of light, and thus also heat, is conspicuously shown in its effect where slopes with a southern exposure are contrasted with definitely northern slopes as to floral society and development.

Light is not the limiting rod of measurement of heat, for the effect of altitude variation is shown in spite of same amounts of light. Study Figure 11 and notice how that in the basins which often are farther north than some southern parts there is a much longer period of total frost free days per year. (Wilson[7]) This total yearly temperature has much to do in determining the type of floral climax possible.

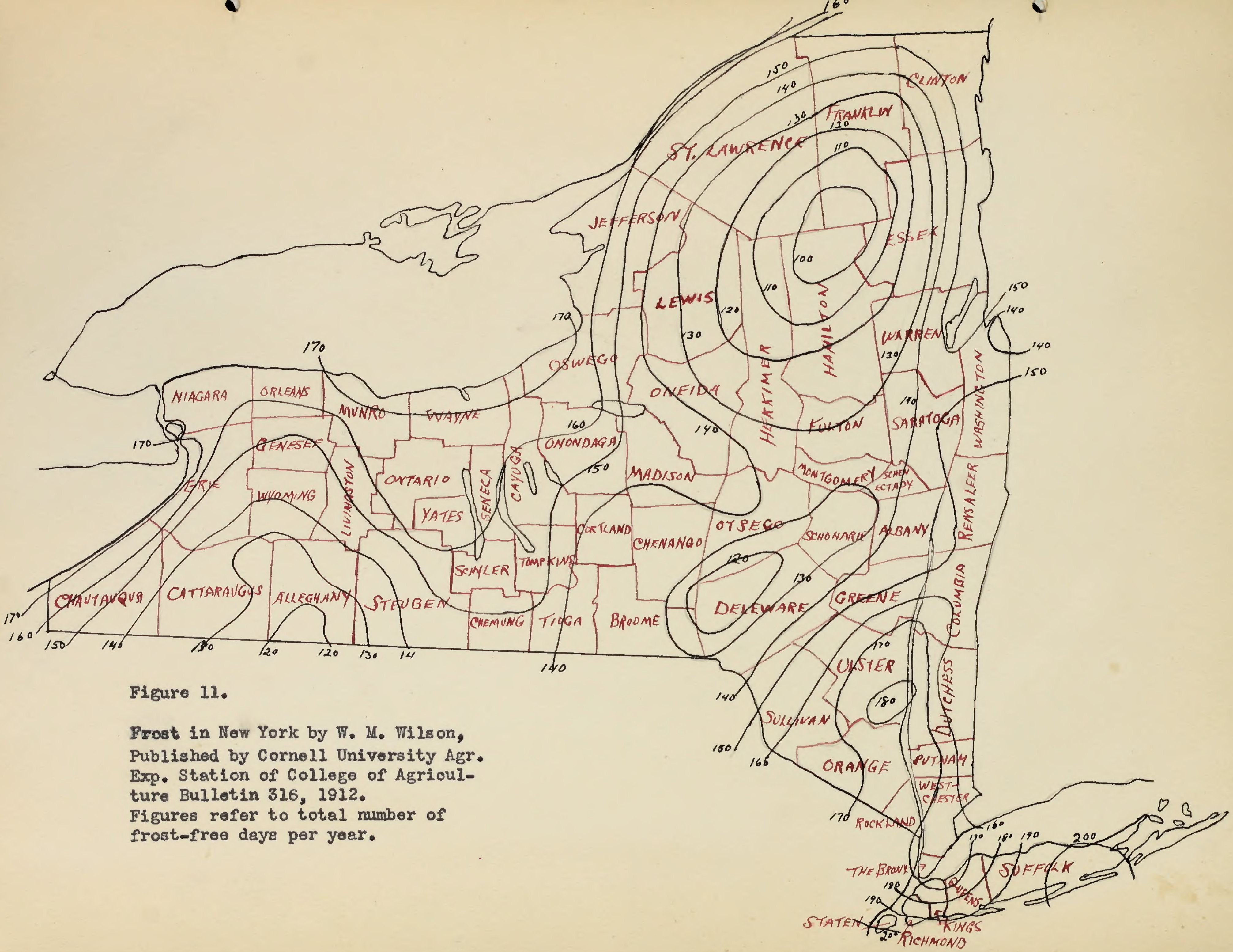


Figure 11.

Frost in New York by W. M. Wilson, Published by Cornell University Agr. Exp. Station of College of Agriculture Bulletin 316, 1912.
Figures refer to total number of frost-free days per year.

Figure 12 shows the mean temperature per year of the State of New York. Comparison with Figure 11 shows a rather close correlation between the total frost free days per year and the temperature mean. Further comparison with Figure 14 shows the close correlation between the total frost free period per year (which represents the growing period), the total mean temperature per year (which loosely represents the optimum temperature for any area) and the type of floral climax found in any sizable area. Thus in the Ontario Lake Basin and the larger part of the Hudson River Basin where the total frost free period averages one hundred fifty to one hundred seventy days, and the temperature mean for a year averages forty-five to fifty degrees, we have a floral climax of the Upper Austral type (Zone 2) indicated by the frequency of chestnut, oaks, and hickories. Similarly, we observe in the Long Island region where the total frost free period reaches as high as two hundred days with an annual temperature mean of fifty to fifty-five degrees the typically Austral flora with more southern species of persimmons, sweet gum and willow oak. Other interesting similar comparisons are to be made in the Adirondack Mountain area, the Catskills and the Alleghany shed.

The relationship between available moisture or water supply and the type of vegetation has already been discussed under hydrophytic and xerophytic conditions, but the emphasis on the relationship was from the viewpoint of in-the-soil condition. Figure 13 shows the mean rainfall in inches

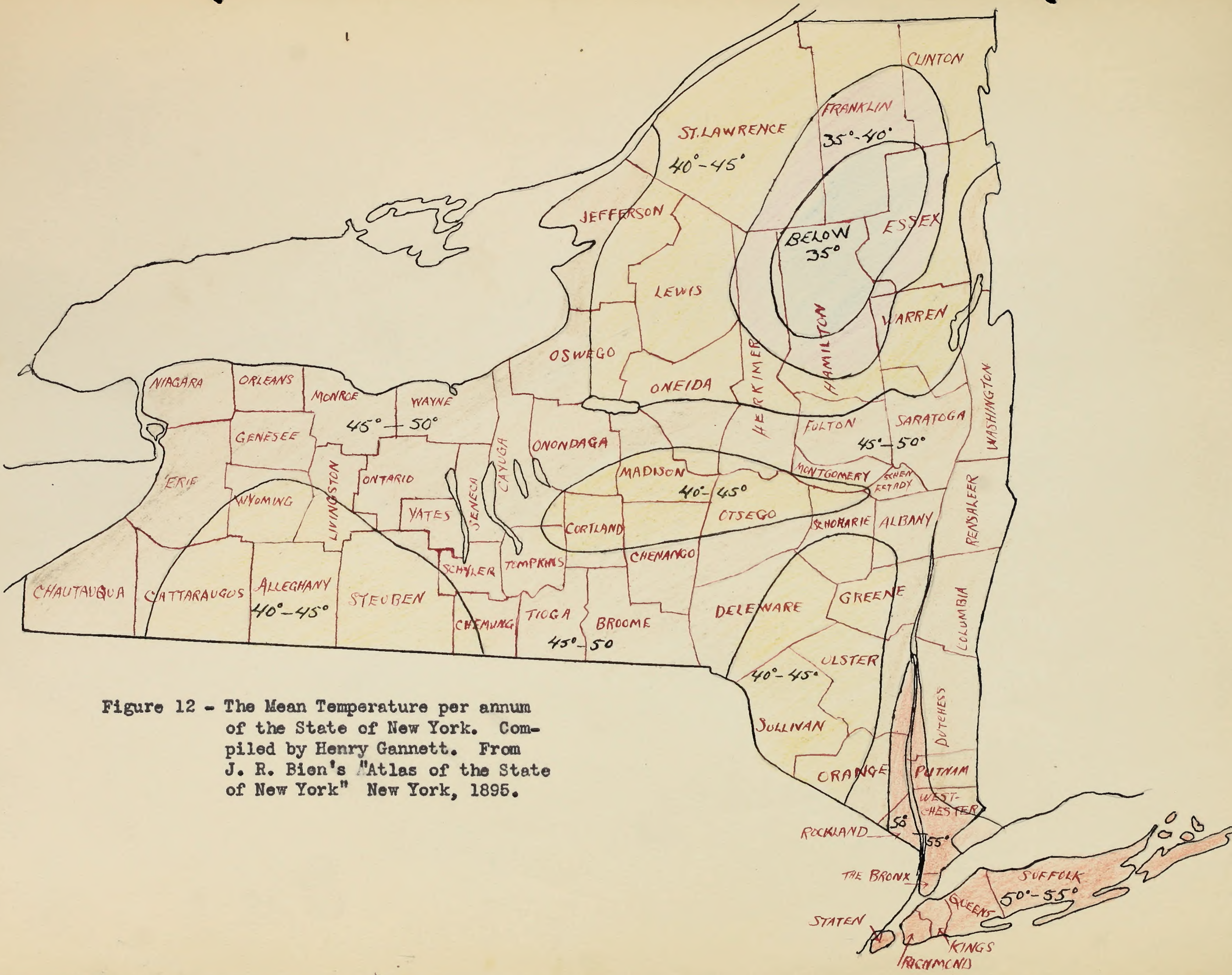


Figure 12 - The Mean Temperature per annum of the State of New York. Compiled by Henry Gannett. From J. R. Bien's "Atlas of the State of New York" New York, 1895.

per year in New York. We find a variance of over twenty inches of rainfall within the state. We observe a similar distribution of rainfall and floral conditions, but we notice the modification by other factors. It is not enough to say that in a given area the more the rainfall (within optimum limits) the greater will be the vegetation. The very factors that to a large extent are responsible for an increased rainfall also serve to delimit the type of floral climax. In the southern part of the state much more uniformity of rainfall exists than uniformity of vegetational climax. In a transect from the Catskills to Long Island, a distance of one hundred miles, we find all the variance between climax of the Canadian or boreal type and climax of the Austral type. Similar conditions exist over a transect of one hundred miles from the Mount Marcy region to the Hudson-Mohawk valley, a variance from Arctic to Upper Austral flora.

The chief factor producing this seemingly "opposite" development in view of rainfall and growth is the delimiting combined effect of altitude, decrease of temperature and shortening of growing period. In the higher Adirondacks where the average yearly rainfall exceeds fifty inches and the annual temperature mean is under thirty-five degrees, it must be noted that by far the larger amount of the percipitation will be in the form of snow, which melted still cold, adds little to growth processes and to a large extent quickly runs off the more precipitous terrain. (It must also be noted that

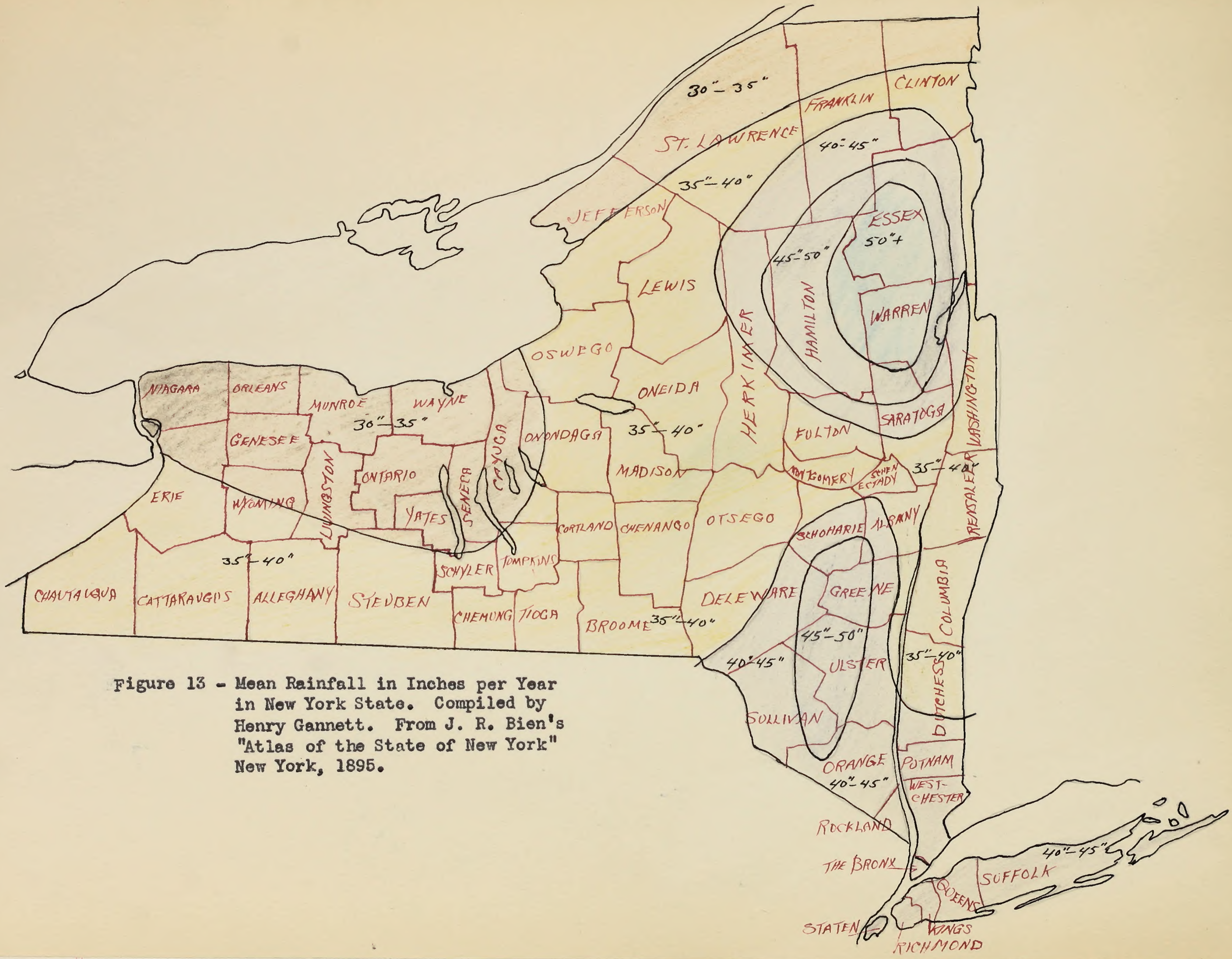


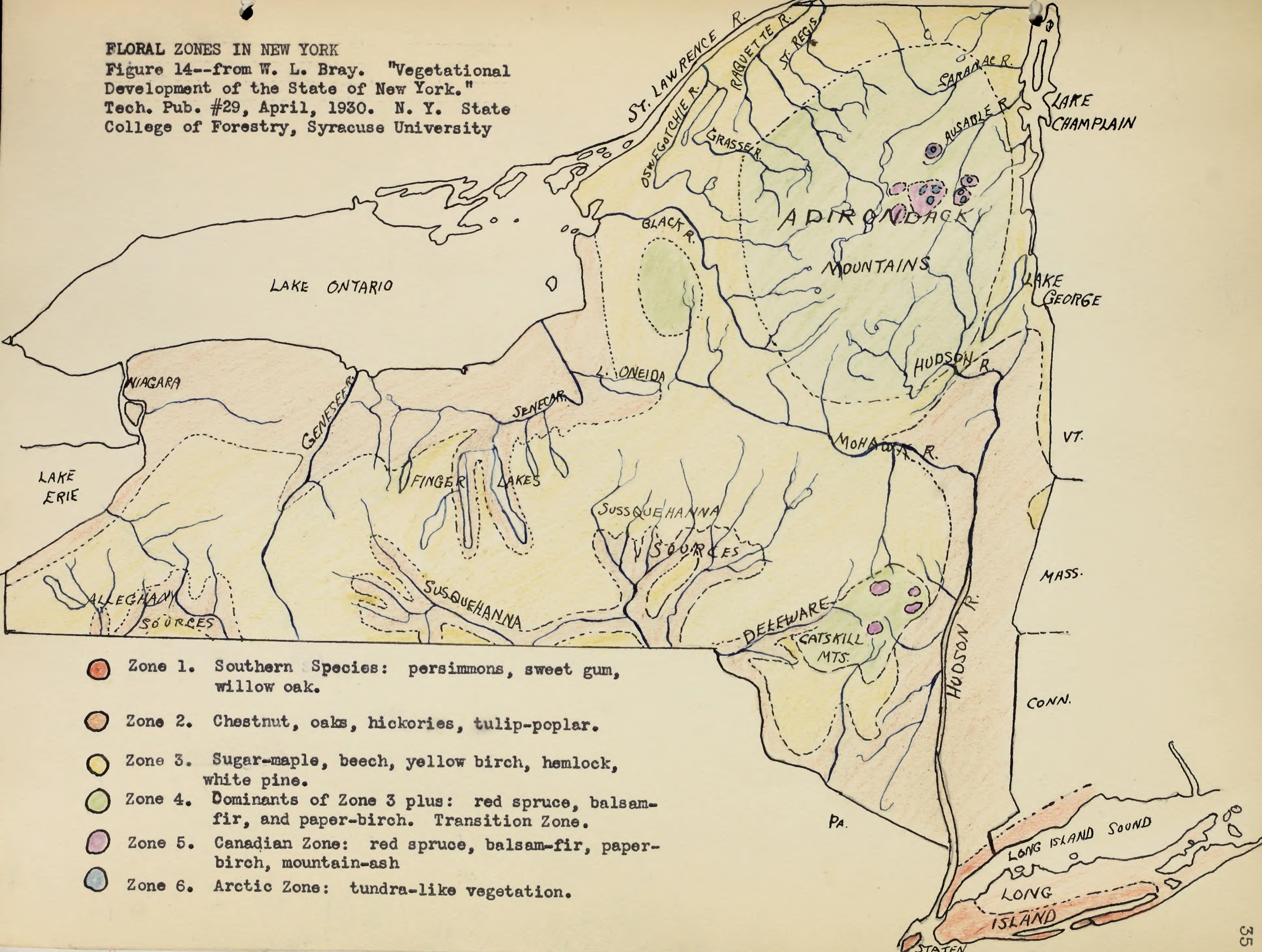
Figure 13 - Mean Rainfall in Inches per Year in New York State. Compiled by Henry Gannett. From J. R. Bien's "Atlas of the State of New York" New York, 1895.

it is possible for the soil to incorporate a larger amount of water in these regions and hold it till the warmer climatic conditions allow abundant growth.) Although abundant, the growth in these regions is thus naturally limited to the hardier northern species by colder soil water condition colder atmospheric temperature and shorter growing period, factors which in part cause each other or are "cocausal".

The effect of large bodies of water is also conspicuous. The east-west position of Lakes Erie and Ontario moderates the climate and as a result extends the Upper Austral zone from the Buffalo-Niagara region east to the Oneida Lake Basin. In constrast, Lake Michigan passes through three floral zones, its nor th-south position having much less effect on the climate. It should be noted, moreover, that the Austral zone extends farther north on the east side of the lake where the prevailing winds are off the water and hence the temperature is moderated. (U.S.D.A.[8]) The effect of the lakes (Figure 14) is further seen in the southward extension of the warmer zone flora along the shores of the Finger Lakes and the shores of Lake Champlain and Lake George. It is true that we have here in addition to the effect of the lakes the effect of lower altitude.

The effects of the large bodies of water are various. They tend to equalize and stabilize temperature. They warm to a greater depth and hold heat longer than land. Evaporation develops a moist blanket of air above and adjacent to the

FLORAL ZONES IN NEW YORK
Figure 14--from W. L. Bray. "Vegetational Development of the State of New York." Tech. Pub. #29, April, 1930. N. Y. State College of Forestry, Syracuse University



Zone 1. Southern Species: persimmons, sweet gum, willow oak.

Zone 2. Chestnut, oaks, hickories, tulip-poplar.

Zone 3. Sugar-maple, beech, yellow birch, hemlock, white pine.

Zone 4. Dominants of Zone 3 plus: red spruce, balsam-fir, and paper-birch. Transition Zone.

Zone 5. Canadian Zone: red spruce, balsam-fir, paper-birch, mountain-ash

Zone 6. Arctic Zone: tundra-like vegetation.

water surfaces. This blanket of air is less affected (or affected more slowly) by temperature fluctuations than dry air is affected. This makes the winters warmer, the summers cooler, the springs later and the autumns later.

Soil conditions vary in the mesophytic climax according to whether the beginning was mesophytic, xerophytic, or hydrophytic in tendency. The first of these conditions would be in the form of a fairly thick layer of soil to which humus additions would bring much organic improvement. The bed in this case would vary according to the type of rock and mineral decomposed in forming the original soil. There is no doubt this type of soil would produce the greatest and most varied flora. Much of the farming area is on this kind of terrain. Clearing has left only scattered remnants in the form of the prized "wood-lot", but even these have usually been lumbered and are now "gardened" or "landscaped" by selection of species (as in sugar woods) and removal of dead wood before the process of decomposition has set in so that the natural sequence is broken. Cattle also often destroy many features of the ground cover in these "lots". Soil in the second of these varies greatly. As in Figure 15, vegetable remains plus very little decomposed rock often make up the only soil cover on a glacial xerophytic terrain. (Here the mesophytic climax has become a white pine, white spruce and maple society, although the photo shows a sub-climax of various birches, maples and young conifers gaining a foothold in the

Figure 15

underbrush. The photo was taken in Essex County, New York. Figure 16 shows the ground or soil conditions prevailing at 3,300 feet on Whiteface Mountain, with a stand of typical Canadian-Transition zone flora, a spruce, balsam-fir, paper-birch society. Here the roots are very shallow and the bed stained by the leaching of humus organic matter.

Figure 9 illustrates the soil conditions of the third type of soil terrian. The rate of humus accumulation varies with the general acidity of the soil, the tendency being the more acid the soil, the more slowly plant growth and consequently humus formation takes place.

Finally the characteristics of climax mesophytic forest can be summarized as in the following outline from Bray's[2] discussion of factors of growth.

I. Soil.

1. It is well-drained and well-ariated.

Figure 16

2. It is populated by many inter-dependent living organisms of both live roots and living bacteria which help change decaying organic matter to a usable form of soluble nitrogen.
3. Soil is mechanically changed by great roots piercing it.
4. It is rich in available soil nutrients.

II. Growth Forms:

1. Deciduous trees of broad-leaved plants.
2. Conifers of needle-shaped leaves.
3. Evergreens of broad leaves.
4. Shrub types.
5. Climbing vines.
6. Perennial rootstocks--small woody plants.
7. Monocotyledonous and dicotyledonous annuals.
8. The bulk of spring flowers in forms of: bulbs, corms, rhizomes, rootstocks.
9. Ferns, club-mosses.

III. Growth relations:

1. Differentiated light conditions of high forest foliage.
2. Atmospheric conditions (heat, cold, air movement, reduced evaporation from floor of forest, rainfall).
3. Distribution of roots in forest society.
4. Saprophytic and symbiosic bacterial action.
5. Mycorhiza (on beech, birch, pine, and hemlock).

6. The combination of factors that maintains equilibrium or stability of the climax bringing on the stabilizing of the soil conditions.

B. The Floral Zones of New York as Mesophytic Climax

Merriam[9] would place New York as a state in a Transition zone - the overlapping of a southerly group of oaks and chestnuts with a more northerly group of birches, beeches, sugar maple, and hemlock. Thus considered, New York State would not include the Canadian-Transition or true Canadian boreal zone.

It is true that the state as a whole does seem to possess floral contrasts. There is in various parts well-developed boreal vegetation indicated by balsam-fir, red spruce, and paper birch, a climax which reaches its greatest development in Canada much farther north. On the other hand, we find clearly defined regions of the great south Appalachian hardwood vegetation, known as the Austral zone, reaching its greatest development southward and southwestward through Tennessee, Arkansas, and eastern Texas. New York becomes a meeting ground or truly a transitional stage. This transitional region is composed of the familiar types of maple, beech, yellow birch, hemlock and white pine forest. "It may be said to reach its maximum development in the New York type environment." (Bray[2]) Looking for an accounting for this occurrence, we easily see how the Appalachian axis forms an highway for these northern forms to dip south past their

normal coast latitude. Also we note the Atlantic coastal plain, warmed by the effect of the Gulf Stream to a temperature beyond the normal for its latitude, form s an highway for the northward extension of more southern forms as: short-leaf pine, sweet gum, chestnut, willow oak, oak, persimmon, and others, some of them extending through New England as far as Maine. (The northern type of flora dipping southward along the Appalachian axis has a broader distribution of northern forms in the White Mountains of New Hampshire than it does in New York.)

Of the actual species of the flora of New York John Torrey[10] describes 1,450 species, of which 1,200 are herbaceous (150 ornamental), 250 woody plants (eighty with stature of trees). By 1924, House[11] describes 3,904 species, of which eighty-nine are pteridophytes, twenty-three are gymnosperms, 811 are monocotyledonous and 1,981 are dicotyledonous. House's number had more than doubled that of Torrey. This feature is easily accounted for by the amount of collecting that had been done for the State herbarium from 1840 to 1920, roughly sixty years. House's number will have additions by the next time an attempt is made to present the complete flora of New York. Torrey gives some proportions of outstanding families of plants that are still as t rue as when noted by him. The most numerous of the dicotyledonous plants are: Ranunculaceae (1/38 of total number), Scrophulariaceae (1/39), Umbelliferae (1/59),

Cruciferae (1/45), Leguminosae (1/26), Rosaceae (1/25), Compositae (1/9), Ericaceae (1/34), Labiatae (1/32); of the Monocots: Orchidaceae (1/39), Cyperaceae (1/9), Gramineae (1/12). These few families alone constitue nearly 60% of the total flora. Of these few alone Cyperaceae, Gramineae and Compositae equal 30% of the group. These proportions will vary but little from the average f or the whole flora of North America.

Following is a listing of the floral zones of New York State and their indicator species presented by Bray[2]. The scientific names cited have been corrected to comply with the nomenclature of Gray's Manual.

FLORAL ZONES OF NEW YORK STATE AND THEIR INDICATOR SPECIES

1. Zone of Willow Oak, Sweet Gum, Persimmon, etc.

Indicator Species:	
Short-leaf pine	Pinus echinata Mill.
Willow oak	Quercus phellos L.
Black oak	Quercus velutina Lam.
Black-jack oak	Quercus marilandica Muench
Laurel magnolia	Magnolia virginiana L.
Sweet gum	Liquidambar Styraciflua L.
Hop-tree	Ptelea trifoliata L.
Mistletoe	Phoradendron flavescens (Pursh) Nutt.
Virginia Spiderwort	Tradescantia virginiana L.
Day flower	Commelina virginica L.

Distribution: Staten Island, southern Long Island coastward, and a narrow strip along the Sound from Manhattan and the Brox to and along the Connecticut coast. There are about two hundred frost free days over this area. In addition to those named above the species of Zone 2 and some of Zone 3 are to be found in this area perhaps in even greater numbers than the indicators of Zone 1 itself.

2. Zone of Dominance of Oaks, Hickories, Chestnut, Tulip-tree, etc.

Indicator Species:

Red cedar	Juniperus virginiana L.
Black walnut	Juglans nigra L.
Butternut	Juglans cinerea L.
Hickories	
Bitternut or swamp hickory	Carya cordiformis (Wang) K. Koch
Shag-bark or shell-bark	Carya ovata K. Koch
King-nut or big shag-bark	Carya laciniosa (Michx.f.) Loud.
White-heart hickory, mocker-nut	Carya alba (L.) K. Koch
Small-fruited hickory	Carya microcarpa Nutt. Britton
Pignut hickory	Carya glabra (Mill.) Spach.
Oaks	
Red oak	Quercus rubra L.
Swamp or pin oak	Quercus palustris Muench.
Scarlet oak	Quercus coccinea Muench.

Black oak	Quercus velutina Lam.
Gray oak	Quercus ellipsoidalis E. J. Hill
White oak	Quercus alba L.
Post or iron oak	Quercus stellata Wang.
Mossy-cup or burr oak	Quercus macrocarpa Michx.
Swamp white oak	Quercus bicolor Willd.
Rock chestnut oak	Quercus prinus L.
Chestnut or yellow oak	Quercus Muhlenbergii Engelm.

<u>Others</u>

Sweet birch	Betula lenta L.
Chestnut	Castanea dentata (Marsh) Borkh.
Hackberry	Celtis occidentalis L.
Red mulberry	Morus rubra L.
Cucumber tree or Mountain magnolia	Magnolia acuminata L.
Tulip-tree or yellow poplar	Liriodendron tulipfera L.
Papaw	Asimina triloba Dunal
Sassafras	Sassafras variifolium (Salisb.) Ktze.
Wild hydrangea	Hydrangea arborescens L.
American crab-apple	Pyrus coronaria (L.)
Sycamore	Platanus occidentalis L.
Red-bud	Cercis canadensis L.
Kentucky coffee-tree	Gymnocladus dioica (L.) Koch.
Honey-locust	Gleditsia triacanthos L.

Prickly-ash	Xanthoxylum americanum Mill.
Flowering dogwood	Cornus florida L.
Tupelo	Nyssa sylvatica Marsh.
Great laurel	Rhododendron maximum L.
Mountain laurel	Kalmia latifolia L.

Some of the small herbaceous species

White dog-tooth violet	Erythronium albidum Nutt.
Lizards tail	Saururus cernuus L.
American Lotus or Water chinquapin	Nelumbo lutea (Willd) Pers.
Golden-seal	Hydrastis canadensis L.
Wild sensitive plant	Cassia nictitans L.
Partridge-pea	Cassia Chamaecrista L.
Shooting-star	Dodecathion Meadia L.
Virginia cowslip or bluebell	Mertensia virginica (L.) DC.

There are found in addition to these certain other of the austral group of plants, e. g., Smilax, legumes, composites, certain grasses, which are represented rather strongly in this zone but disappear or are sparsely represented in Zone 3. This list could be very much lengthened, but the above list gives a fair representation of the zone.

Distribution of Zone 2: Upper part of Long Island and Staten Island; Hudson Valley region and adjacent highland valleys, becoming thinned out by the disappearance of many species (chestnut stopping below Lake Champlain, red oak, white oak, shell-bark hickory, red-cedar and some others extending on

up to the St. Lawrence); the Delaware, Susquehanna, and Alleghany drainage valleys; the Finger Lake valleys; the Mohawk Valley especially on southern exposure; the narrow Erie belt and the broader Ontario-Iroquois basin (chestnut very notable on sandy soils) to the Oneida Lake basin; and northward thinning out by the disappearance of chestnut, tulip-tree, certain oaks and hickories toward the St. Lawrence valley. Also low elevations to twelve hundred feet more or less and in territory under the influence of the maritime and the lakes.

The frost-free period in this area is about one hundred sixty to one hundred seventy days. Where "thinned out" conditions of the zone occur the period is only one hundred fifty days.

3. Zone of Dominance of Sugar Maple, Beech, Yellow Birch, Hemlock, and White Pine Mixed Forest. Alleghany-Transition Zone.

Indicator Species:

White pine	Pinus Strobus L.
Hemlock	Tsuga canadensis (L.) Carr.
Hop hornbean	Ostrya virginiana (Mill.) K. Koch
Blue or Water beech	Carpinus caroliniana Walt.
Yellow birch	Betula lutea Michx. f.
Witch hazel	Hamamelis virginiana L.
Juneberry	Amelanchier canadensis (L.) Medic.

Wild black cherry	Prunus serotina Ehrh
Sugar maple	Acer saccharum Marsh.
Red maple	Acer rubrum L. Notably in swamps
Striped maple	Acer pennsylvanicum (common also in Zone 4)
Mountain maple	Acer spicatum Lam.
Basswood	Tilia americana L.
White ash	Fraxinus americana L.

Also in this zone is found about the maximum growth of the forest floor herbaceous growth-forms which comprise generally the popularly favorite spring woodland flora of the eastern half of the continent. It appears they are rendered less susceptible to the cold winters and climatical extremes on account of their close relation to the deep-warm soil blanket of climax forests. Some of these species referred to above are: Virginia grape fern, hay scented fern, christmas fern, evergreenwood fern, maiden hair fern, plantain-leaved sedge, jack-in-the-pulpit, wild leek, yellow adder's tongue, false spikenard, bell-worts, solomon's seal, indian cucumber, large-flowered trillium, showy orchis, wild ginger, carolina spring beauty, red baneberry, white baneberry, wild columbine, tall anemone, hepatica, tufted buttercup, early meadow rue, blue cohosh, twinleaf may apple, blood root, dutchman's breeches, squirrel corn, pepper root, two-leaved toothwort, bishop's cap, barren strawberry, downy yellow violet, striped violet, long spurred violet, american spikenard, ginseng, ground-nut,

aniseroot, sweet cicely, indian pipe,and beech drops.

Distribution in New York: There is a tendency for this group to occur upon every edaphic situation throughout the state up to two thousand feet (in the Catskills) excepting in general the Adirondacks, but dominant over the Alleghany plateau region and the Catskills below the spruce-balsam line.

The number of frost-free days where this flora is found is about one hundred thirty to one hundred fifty.

The zone is more or less arbitrarily distinguished from the maple, beech, birch, hemlock, of the Adirondacks and Catskills which contain and are often dominated by red spruce, balsam, white birch, etc., on the one hand and presence of some species of Zone 2 which are lacking in the Adirondacks.

4. Canadian-Transition Zone:

This zone has as dominants maple, beech, yellow birch and white pine as in Zone 3, but in addition (and with a tendency to dominate in special situations, higher altitudes in particular) red spruce, balsam, paper birch, mountain ash, etc. It is further characterized by a conspicuous decreasing of forest floor herbaceous growth-forms of the Appalachian region generally, and the more frequent appearance of more northerly species.

Dominant Trees:

Red spruce	Picea rubra (DuRoi) Dietr.
Black spruce	Picea mariana (Mill.) BSP.

Balsam fir	Abies balsamea (L.) Mill.
Mountain ash	Pyrus americana (Marsh.) DC.

Forest Floor Species of Special Note:

The following not only occur generally distributed throughout the Adirondacks and highest Catskills, but each may occur in large stretches as an exclusive formation.

Shield fern	Aspidium spinulosum var. intermedium (Muhl.) DC. Eaton
Hobble bush	Viburnum alnifolium Marsh.
Shining club-moss	Lycopodium lucidulum Michx.
True wood-sorrel	Oxalis Acetosella L.
Ground hemlock	Taxus canadensis Marsh.

Others of this zone but occurring in 3:

Red-berried elder	Sambucus racemosa L.
Bush honesuckle	Diervilla Lonicera Mill.
Wild sarsaparilla	Aralia nudicaulis L.
Fetid currant	Ribes prostratum L'Her.
Large-leaved golden-rod	Solidago macrophylla Pursh.
Mountain aster	Aster acuminatus Michx.

The following becomes more conspicuous in the Adirondacks largely because of the absence of the forms above cited:

Bunchberry	Cornus canadensis L.
Yellow clintonia	Clintonia borealis (Ait.) Raf.
Twin flower	Linnaea borealis L., var americana (Forbes) Rehder.
Two-leaved Solomon's seal	Maianthemum canadense Desf.
Stiff club moss	Lycopodium annotium L.

Gold thread	Coptis trifolia (L.) Salisb.
One-flowered pyrola	Moneses unifolia (L.) A. Gray

Distribution in New York:

In the Catskills from about two hundred feet to thirty-seven hundred feet (above which Canadian Zone forest is indicated by dropping out of maples, beech, hemlock, and pine) and in the Adirondacks generally as climax forest up to thirty-five hundred feet. Growing season one hundred to one hundred thirty days.

5. Canadian Zone. Dominance of Red Spruce, Balsam, and Paper Birch.

Indicator Species:

Red spruce	Picea rubra (DuRoi) Dietr.
White spruce	Picea candensis (Mill.) BSP.
Black spruce	Picea mariana (Mill.) BSP.
Balsam fir	Abies balsamea (L.) Mill.
Paper birch	Betula alba L. var papyrifera (Marsh) Spach.
Mountain ash	Pyrus americana (Marsh.) DC.
Fetid currant	Ribes prostratum L'Her.
Bunchberry	Cornus canadensis L.
Twin flower	Linnaea borealis L., var. americana (Forbes) Rehder.
Creeping snowberry	Chiogenes hispidula (L.) T. & G.
Gold thread	Coptis trifolia (L.) Salib.
Yellow Clintonia	Clintonia borealis (Ait.) Raf.
Stiff club moss	Lycopodium annotinum L.

Large-leaved golden-rod	Solidago macrophylla Pursh.
Mountain aster	Aster acuminatus Michx.

Increase of boreal (or bog) heath shrubs

Increase in lichens

Increase in mosses

Distribution:

Not exactly typical on summits of highest Catskills but indicated by dominance of red spruce and balsam, much somewhat gnarled topped yellow birch, and sparse paper birch and by forest floor species. In the Adirondacks, the zone of spruce, balsam, paper birch and mountain ash which succeeds maple, beech, birch, hemlock, and white pine above thirty-five hundred feet more or less, is here referred to the Canadian Zone which in its typical composition as described by Cooper is the Northeastern conifer forest par excellence.

6. Zone of Arctic Flora of Adirondack Peaks

Indicator Species:

Fir club moss	Lycopodium Selago L.
Alpine holy-grass	Hierchloe alpina (Sw.) R. & S.
Mountain spear-grass	Poa laxa Haenke
Small-flowered wood-rush	Luzula parviflora (Ehrh) Desv.
Scirpus-like sedge	Carex scripoides Schkuhr.
Highland rush	Juncus trifidus L.
Bearberry willow	Salix Uva-ursi Pursh.
Glandular or scrub birch	Betula glandulosa Michx.

Black crowberry	Empetrum nigrum L.
Diapensia	Diapensia lapponica L.
Lapland rose-bay	Rhododendron lapponisum (L.) Wahl.
Moss-bush	Cassiope hypnoides (L.) D. Don.
Cutler's alpine golden rod	Solidago Cutleri Fernald
Low rattlesnake-root	Prenanthes Boottii (DC.) Gray

Occurrence in New York:

The Mount Marcy group above five thousand feet; on Mount McIntyre and to a less degree on Whiteface Mountain and other high peaks.

The foregoing list of floral zones and their indicator species are graphically illustrated in Figure 14. The allocation of these zones is general; for example, floral members of zone 2 are found farther up the Mohawk Valley than is indicated. The same is true in the Champlain Valley; far up the valley of Lakes George and Champlain "thinned out" zone 2 persists. Figure 17 near Ticonderoga shows a typical "stand" of hickories which are regular indicators of zone 2. Figure 18 near the same area as

Figure 17

Figure 18

Figure 18 shows typical oak, rock maple, and hickories with fairly sizable chestnut saplings which have grown up since the chestnut blight destroyed the larger trees.

In a similar way typical growth of the zone 3 prevails farther up the rivers rising in zone 4 of the Adirondack region as illustrated by Figure 19, a photo taken near the source of the Saranac River. The "overlapping" of typical zones by modified conditions such as a broad river valley with close-by mountain heights thus makes possible a greater floral variety in the climax than in an area of zone 2, for example. The method of zone identification may be more fittingly applicable in general to a larger area but its lines of demarcation are definite in regions of rapidly increasing altitude as indicated by Figure 20. The ridges above

Figure 19

"timber-line on the rocky-ledges support tundra-like vegetation of the Arctic zone 6. On a nearby mountain, Mount Marcy, Harshberger[12] describes the "Krumm holz" or dwarf timber cover of approximately 5,000 feet in altitude. He notes: Abies balsamea (not over five feet in height) with Linnaea americana,

Figure 20

A - Arctic zone flora, B - Boreal or typical Canadian zone flora, C. T. - Canadian-Transition.

Chiogenes hispidula and Cornus canadensis beneath, while Vaccinium canadense and Pyrus americana are prominent shrubs.

The Arctic Zone in New York State is confined to the tops of Mount Marcy, the Gothics, Mount McIntyre, Whiteface Mountain and in very limited amounts to a few others of the highest points. Figure 21 shows a typical ground cover of tundra-like vegetation of zone 6 as found on the mountains mentioned.

Figure 21, Whiteface Mt.

Figure 22 shows more nearly typical mountain-top plateau growth of the type of zone 5 or the boreal or Canadian zone; photo taken on Whiteface range looking northeast. It is interesting to note that this type of growth extends downward to much lower altitudes on the northern slopes of mountains than it does on southern exposures, the transitional type of vegetation reaching to higher elevations under more favored temperature and light conditions. The boreal zone growth seems to reach its optimum between 3500 and 5000 feet on higher mountains and on mountains under 4000 feet scarcely appears except when bog-like conditions prevail, owing to abundant moisture supply. Peck[13] considers the black spruce an indicator of boreal conditions and considers the appearance of sizable "stands" of

Figure 22

them in various points outside of the typical boreal zone, as in Rennsselaer County, due to bog-like conditions which is almost the same as to say boreal conditions.

The appearance of these more northern vegetational climaxes or societies does not minimize the fact that the typical original climax of the state was mesophytic, of the type of growth as found in zone 3, white pine being the only evergreen found generally over the state with hemlock frequently in the society. Another evergreen, arbor vitae, is peculiar because of its appearance under vastly varying conditions ranging from near-xerophytic and scattered over the domain of zone 3. Almost pure stands are often found on almost pure sand. Again, it may appear on bog-like or swamp-like terrain in the same peculiar pure stands. It is also often found occupying very rugged rocky ledges. As already mentioned, typical zones 1, 2, and 3 have been greatly altered by city development and agriculture.

V. Summary

Drawing together the various phases of the subject dealt with in the above pages, the writer draws the following conclusions:

1. That the floral background of the State of New York, developing from the viscissitudes of geological change has had a profound influence upon the present floral conditions. The effect of any period of gigantic ice coverings would be enough to destroy local vegetation, and a species as well, if it could not retreat to a position where it could survive. The consequent tearing and defacing of the terrain and the melting of ice would produce the conditions of all three main types; xerophytic, hydrophytic, and mesophytic, so that vegetation returning would have to work from conditions least favorable or less favorable to conditions more favorable, in a manner necessarily quite similar to the process by which vegetation would now occupy a recently available terrain or condition for plant invasion or re-occupation.

2. That the State of New York is typically mesophytic in its floral climaxes. Within the general area of the state are occasional excepted areas tending more toward xerophytic or hydrophytic conditions, but the factors at work in even these excepted areas are producing typical mesophytic conditions as rapidly as consistent vegetational development produces them from the particular type of condition prevailing beforehand.

3. That the State of New York is typically Transitional in its floral climax, but the modification by altitude and the effects of bodies of water (Great Lakes and Gulf Stream) causes the development of climax typical of more northern climax on the one hand and of more southern climax on the other.

4. That the natural vegetational climax has been very much interrupted permanently by agriculture and city development. The Austral type of flora of Staten Island, the Bronx, Richmond, and western Long Island has been all but removed by city development. Zones 2 and 3 have been much interrupted by farming. Zones 4 and 5 have been lumbered until the mountain regions are pillaged weed patches compared with what they were.

5. That it is expedient that all within the limits of man be done in favor of natural vegetational development in restoring as large areas as possible to their former capacities. In doing this it is important that true values be recognized in determination of what lands would be profitably kept for agricultural purposes. By wise selection of plant species for an unproductive area will usually result in the yielding of a valuable crop on that area. Figure 23 clearly shows the result of wise reforestation on sand-country near Saranac Lake. This type of work is being done

Figure 23

increasingly over the state, often by private citizenry. Wise lumbering operations can be carried on to the end they produce almost the same conditions as reforestation and in some ways conditions superior to reforestation.

6. That in spite of the effects of man natural recourse tends to vegetational "correction". This is very easily observed in the case of abandoned farms. Fields become occupied with many weed forms, followed by shrubbery capable of competing with a firm turf of grass, sedge, and other small root forms, after which typical mesophytic forest saplings precede the forest climax. Figure 24 shows a large mountain area of typical Canadian-Transition growth that has had its spruce lumbered and is recovering its former climax. Paper birch gained temporary predominance because it grows faster

Figure 24

than spruce, and seedlings were likely left growing when the spruce was removed. The red spruce is gaining a good foothold in the underbrush, often dominates and will become finally dominant.

7. Finally, that the vegetational development of any area is not a blind chance development resulting from limitation of natural supply of species and forms, but it is the natural, balanced progression of growth regulated by persistent factors or forces effectively modifying any circumstance to the point where it permits the greatest possible development or climax of that area. Finally, the greatest factor in the developing of any vegetational climax is vegetation, itself, at work.

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